

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

STRUCTURE FOR WATER CONTROL

(No.)
CODE 587

DEFINITION

A structure in an irrigation, drainage, or other water management system that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation.

PURPOSE

To control the stage, discharge, distribution, delivery, or direction of flow of water in open channels or water use areas. Also used for water quality control, such as sediment reduction or temperature regulation. These structures are also used to protect fish and wildlife and other natural resources.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies wherever a permanent structure is needed as an integral part of an irrigation, drainage, or other water-control systems to serve one or more of the following functions:

1. To conduct water from one elevation to a lower elevation within, to, or from a ditch, channel, or canal. Typical structures: drops, chutes, turnouts, surface water inlets, head gates, pump boxes, and stilling basins.
2. To control the elevation of water in drainage or irrigation ditches. Typical structure: checks.
3. To control the division or measurement of irrigation water. Typical structures: division boxes and water measurement devices.
4. To keep trash, debris, or weed seeds from entering pipelines. Typical structure: debris screens.
5. To control the direction of channel flow resulting from tides and high water or backflow from flooding. Typical structures: tide and drainage gates.

6. To control the level of a water table or to remove surface or subsurface water from adjoining land, to flood land for frost protection or to manage water levels for wildlife or recreation. Typical structures: water level control structures, pipe drop inlets, and box inlets.
7. To provide water control for recreation for similar purposes.
8. To convey water over, under, or along a ditch, canal, road, railroad, or other barriers. Typical structures: bridges, culverts, flumes, inverted siphons.
9. To modify water flow to provide habitat for fish, wildlife, and other aquatic animals. Typical structures: deflectors, chutes, cold water release, or structures to make pools and riffles.

CRITERIA

General. Structures shall be designed on an individual job basis, or applicable NRCS standard drawings shall be adapted, to meet site conditions and functional requirements. Designs shall be based upon site surveys, required hydraulic functions and soils/foundation investigations. Structures not covered by Standard Designs/Drawings shall be designed in accordance with current NRCS engineering handbooks and associated technical materials.

Provisions must be made for necessary maintenance. Care must be used to insure that the area's visual resources are not damaged. If watercourse fisheries are important, special precautions or design features may be needed to allow fish passage.

Foundation. The extent of foundation investigations shall be based upon the size and importance of the structure, geology of the area, water table considerations and the initial findings of the investigations. The foundation materials

shall have adequate bearing strength to support the structure, adequate resistance to piping and sliding and should be relatively homogeneous so as to prevent undesirable settlement or differential settlement or specific structural considerations and/or foundation treatment shall be included in the design for such conditions.

Capacity. Structures shall have the capacity to carry the design flow with adequate freeboard, remain stable, control downstream erosion and keep the upstream and downstream water surfaces within the limits allowed.

Structural. Structures for water control shall be designed to withstand the anticipated loads from internal and external loading, hydrostatic uplift, surcharge loads, surface and impact loads, water pressure due to seasonally high water tables, frost and ice pressures. Refer to NRCS Technical Release 74, "Lateral Earth Pressures".

Freeboard. The following minimum freeboard shall be provided:

Structure Type	Design Flow	Freeboard
Irrigation Ditch structure	6 cfs or less	4 inches
(e.g. checks, turnouts,	6 to 15 cfs	6 inches
diversion boxes, drops	15 to 50 cfs	9 inches
of F < 4-feet)		
Inverted Siphon	Same as above plus	
Inlets & Outlets	plus $0.2V^2/2g$	
	Where V = pipe velocity	

Standard Drawings. The use of Idaho Standard Drawings numbered ID-SD-587A through ID-SD-587R shall be governed by the following limitations:

1. Depth of notch for drop structured shall not exceed 4 feet.
2. Height of drop shall not exceed two feet.
3. Length of crest shall not exceed four feet.
4. Total height of any wall shall not exceed 4-1/2 feet except for pipe inlets where the width to height ratio is less than 1.
5. The apron length for drop structures shall be not less than five times the flow depth over the crest at design flow.

When structure sizes exceed any of these limitations, hydraulic and structural computations are required to support the design.

Drop Structure Design. The crest elevation of drop structures in a system shall not be lower than the end sill elevation of the next upstream

structure or the bottom of a stable ditch 300 feet upstream, whichever is closer. Exceptions are ditches in soils where a nonerosive velocity can be shown by design using a Mannings "n" coefficient of no higher than 0.025. For installations where grade is permitted between structures, riprap, the greater of four feet or one apron length, shall be provided downstream of each structure.

The crest length should not be wider than the bottom width of the ditch. Table 1 can be used to select the structure crest length for various combinations of flow depth and capacity. The design notch depth for the structure shall include the required freeboard and water flow depth.

TABLE I
Drop Structure Capacity* (cfs)

Flow Depth (Ft)	Crest Length (Ft)				
	1.0	1.5	2.0	2.5	3.0
0.5	1.2	1.75	2.33	2.9	3.5
1.0	3.3	4.95	6.6	8.25	9.9
1.5	6.1	9.1	12.1	15.2	---

Computed by $Q = 3.3 LH^{3/2}$

Apron widths should conform to the ditch bottom width immediately below the structure and shall not be narrower than the crest length.

For structures with two feet or less drop, the apron length should not be less than the height of the drop plus three times the depth of water above the crest. Apron length for structures with a drop greater than two feet shall be determined using National Engineering Handbook (NEH), Section 11, Drop Spillways, or from criteria contained in approved standard drawings.

At the high water line, the upstream headwall extensions shall extend into solid earth a horizontal distance equal to the cutoff requirements or one foot, whichever is greater. The downstream wingwalls shall extend, at a minimum, to the normal ditch high water line.

For structures with a design flow of 15 cfs or less and a wall height above the apron of 4-1/2 feet or less, the combined length of the upstream cut-off and downstream toe wall below the apron shall be at least two times the height of drop. This length shall be distributed between the upstream cut-off and toe wall. The toe wall shall extend not less than nine inches below the apron

and the cut-off shall extend not less than 1.0 foot below the apron.

Cut-off requirements for structures larger than 15 cfs or wall height greater than 4-1/2 feet or drop greater than 2 feet shall be determined by using Lane's Theory of Creep in NEH, Section 11, or flow net procedures described in NRCS, Soil Mechanics Note 5, "Flow Net Construction and Use".

Check Structure Design. The basic criteria for drop structures shall apply with the following exceptions.

For check structures with a design flow of 15 cfs or less and a wall height above the apron of three feet or less, the combined length of upstream cut-off and downstream toe wall shall be two times the design height of the check boards. This length below the apron, shall be distributed between the upstream cut-off and the toe wall. The toe wall shall extend not less than nine inches below the apron and the cut-off shall extend not less than one foot below the apron.

Division Box Design. The basic criteria for check and drop structures shall be used for determining headwall, cut-off and wingwall requirements. Additional criteria are as follows:

The cross-sectional area should provide for a flow velocity of about 0.5 feet/second. The size should conform with existing or proposed ditches or pipelines and be adequate to safely distribute the design flow. Division boxes using pipe for distribution shall be proportioned in accordance with criteria for Pipe Inlet and Outlet Structures. Minimum entrance loss shall be computed as $1 + v^2/2g$. Where v = pipe velocity, g = 32.2.

If measuring devices are to be included in the design, the box dimensions shall meet the criteria for the measuring device used. The outlets for division boxes shall meet requirements for grade control structures or the outlet channel shall be riprapped where erosive velocities may occur.

Field Turnouts. Field turnouts shall have adequate capacity to supply the water for the area served. The maximum design ditch water surface shall provide for the required freeboard and water depth plus head losses for the turnout for the type of ditch.

When water velocity in the turnout exceeds three feet/second or the outlet is not submerged, the

outlet shall be protected with rock riprap, sod, or other suitable material.

Turnouts may be sized using Tables 2 through 6. Head referenced in the Tables is defined as the difference in elevation between the ditch and field water surfaces.

When the downstream water level is above the structure crest, corrections to Table 3 can be made using factors from Table 4. Tables 5 and 6 provide minimum acceptable headwall dimensions for pipe turnouts in Idaho. These standard dimensions may be met by either a prefabricated structure of these dimensions or by adding additional headwalls to smaller prefabricated structures.

Materials. Structures may be constructed of aluminum, steel, reinforced concrete, rock, masonry, concrete blocks with reinforcing steel, concrete pipe, timber, and fiberglass. All materials used in constructing structures for water control shall have the strength, durability and workability required to meet the installation and operational conditions required for the site.

Materials used must meet the applicable standard for the kind of materials used (i.e., concrete pipe shall meet the requirements of Practice Standard 430CC, etc).

The selection of the material to be used should take into account the following:

1. The required life of the structure.
2. The pH and salinity of the soil.
3. A cost comparison amortized to account for varying life spans.

Reinforced Concrete. Reinforced concrete structures except for channel linings shall have a minimum member thickness of six inches. The minimum reinforcement for shrinkage and temperature rebar in six-inch members shall be 1/2-inch diameter steel reinforcing bars located on 12 inch centers each way. Designs for R/C structures shall conform to the requirements of NRCS, Technical Release 67, "Reinforced Concrete Design". The minimum section thickness and reinforcement for channel linings shall be in accordance with NRCS, Far West States Engineering Design Standards. The only exceptions shall be officially approved standard drawings.

Concrete Blocks. In general, the structural design of concrete block structures is the same

as for reinforced concrete structures. Structures may be constructed of concrete block manufactured in accordance with ASTM criteria and using the procedures in NRCS Idaho Engineering Technical Note No. 3, "Design Considerations for Concrete Block Structures". Lightweight "Cinder Blocks" are not acceptable.

Metal. Metal used in structures shall meet the structural requirements of the job. The structure metal thickness will be determined for the specific loading conditions. However, for metal pipe riser type structures, the minimum thickness shall be 16 gage.

All metal, aluminum or galvanized coated, shall have a protective coating based upon the requirements of Conservation Practice Standard 430-FF, Steel Pipeline.

Timber. Wood used in structures shall meet the structural requirements of the job. Wood, except for redwood, cedar, and larch, shall be treated with an environmentally safe preservative appropriate for the type of structure, use and species of wood used.

CONSIDERATIONS

Where soil and climatic conditions permit, vegetation should be re-established on all disturbed earth surfaces. If soil or climatic conditions preclude the use of vegetation and protection is needed, nonvegetative means, such as mulches or gravel, may be used. In some places, temporary vegetation may be used until permanent vegetation can be established. The structure can be fenced, if necessary, to protect the vegetation. Seedbed preparation, weeding, fertilizing, and mulching shall comply with the requirements for seeding of critical areas.

Evaluate effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Consider effects on downstream flows or aquifers that would affect other water uses or users.

Consider effects on the volume of downstream flow that might cause environmental, social or economic impacts.

Consider the effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.

Consider the short term and construction-related effects of this practice on the quality of downstream water.

Consider effects of water level control on the temperatures of downstream waters for their effects on aquatic and wildlife communities.

Consider effects on wetlands or water-related wildlife habitats.

Consider effects on the visual quality of downstream water resources.

PLANS AND SPECIFICATIONS

Plans and specifications for installing structures for water control shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall specify the location, grades, dimensions, materials required for the individual structure.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared. The plan will identify needed operational items to achieve intended use. Typical maintenance may include replacing flashboards, replacing displaced rock and earth backfill, trash removal, repair of coatings, and patching of cracks in concrete.

REFERENCES

- King's Handbook of Hydraulics
- National Engineering Handbook, Sections 5, 6, and 11
- Engineering Field Handbook
- Design Standards, Far West States
- Technical Release 67, Reinforced Concrete Strength Design
- Technical Release 74, Lateral Earth Pressures